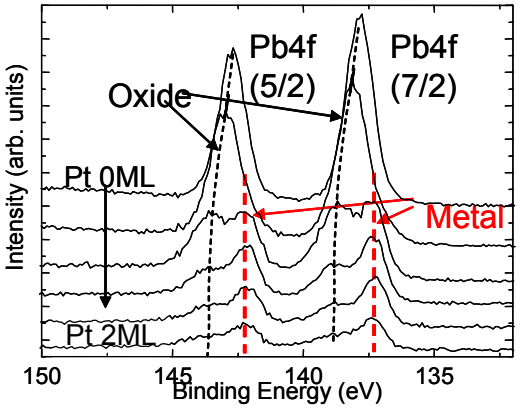
Electronic Structure & Chemistry of Metal/Ferroelectric Interfaces

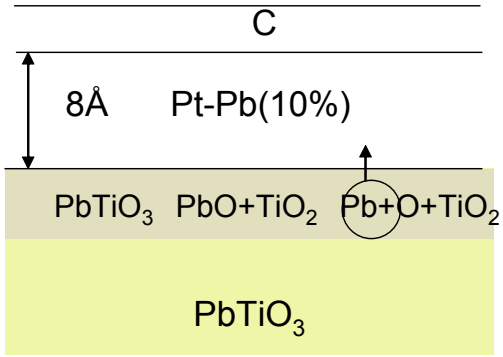
Paul McIntyre and Kyeongjae Cho, Stanford University DMR 0205949

Reliable switching of the polarization state of ferroelectric memory capacitors can be impeded by the presence of non-ferroelectric, "passive", layers at the metal electrode/ferroelectric interfaces. We are studying model interfaces formed between deposited Pt electrodes and single-crystal quality $PbTiO_3$ ferroelectric films. Using a special spectroscopy technique [ARXPS – Fig. 1] we have, for the first time, observed the reaction of Pt with $PbTiO_3$ at room temperature. This results in the formation of a Pb-depleted passive layer in the near-interface region of the lead titanate film [Fig. 2]. The consequences of such reactions for the electrical characteristics of metal/ferroelectric capacitors are now being probed by systematic temperature-dependent conduction measurements [Fig. 3].

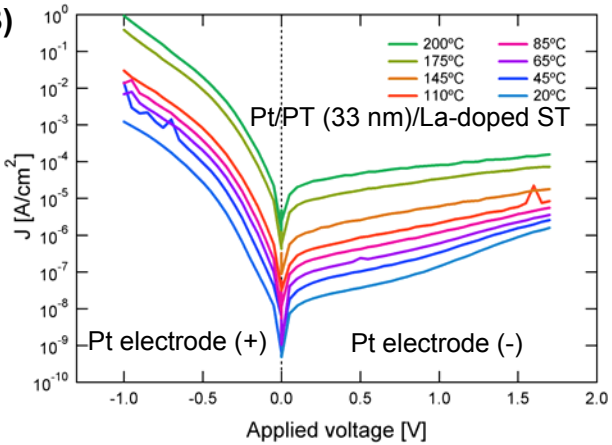
(1)



(2)



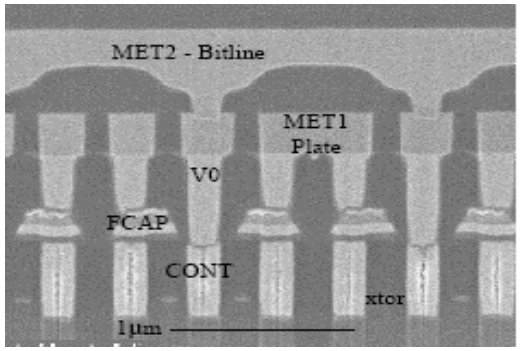
(3)



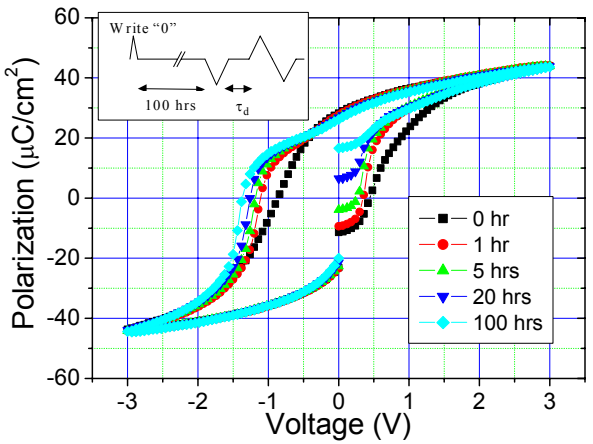
Reliable Ferroelectric Memories

Paul McIntyre and Kyeongjae Cho, Stanford University DMR 0205949

Ferroelectric random access memory (FeRAM) is a promising new semiconductor memory intended for ultra-low power personal communications and computing. FeRAM uses reorientation of nano-size domains in a polar crystal such as $Pb(Zr,Ti)O_3$ to store data as charge on sub-micron capacitors fabricated on silicon chips [Fig. 1]. More widespread use of FeRAM will be possible when local processes responsible for gradual depolarization [Fig. 2] of the $Pb(Zr,Ti)O_3$ capacitors are understood. Stanford students and faculty are studying the physical mechanisms which limit reliable operation of FeRAM. The broad technological impact of our research, which involves active collaborations with US semiconductor companies and semiconductor materials suppliers, may include the successful application of US-manufactured FeRAM in a new generation of hand-held electronic products.



(1) (Moise et al., IEEE International Electron Devices Meeting, San Francisco, 2002)



(2) (Shin et al., Spring MRS Meeting, San Francisco, 2004)